Office of Technical Assistance Research Proposal

Electrically Conductive Adhesives

BACKGROUND

Using solder wire to join electrical connections is a common practice in the electrical equipment industry. Although there was no information presented on the amount of lead solder used for making electrical connections, one has to believe that the quantity is large. These factors combine to explain the widespread distribution of lead in the environment. The EPA has designated lead as a Persistant Bioaccumulative Toxin (PBT), which will require users to report the quantity used on EPCRA 313 Form R. This information will ultimately appear in the Toxics Release Inventory (TRI) database as public information.

One way of eliminating or minimizing lead for this application is to replace it with a conductive adhesive i.e. an adhesive that would possess the same electrical conductivity and bonding properties as lead but would not contain any heavy metals.

Several conductive adhesives have been developed using standard adhesive materials such as epoxy and/or urethane formulated with finely divided metallic silver or copper. These materials have certain drawbacks such as high cost and marginal electrical conductivity.

Hyperion Catalysis International has developed and is marketing various engineering plastics filled with carbon nanofiber materials with the trade name Graphite Fibril. This material has the characteristic of being more electrically conductive than standard carbon black. When the Fibrils are dispersed in engineering plastic matrices, they impart enough electrical conductivity to facilitate electrostatic spray painting of the post-formed plastic parts. In addition, plastics made with fibrils have been designed to dissipate electrical charges in conditions of static electric build up.

SCOPE OF THE PROBLEM

A conductive adhesive could replace the use of solder in wire form. However, not all solder or lead that is reported in TRI by the electronics industry is in wire form. What percentage of the total amount of solder used is wire would be difficult to define. TRI data indicates that 14,870 tons of lead was used as solder in SIC codes 341; 367; 36; & 371. However, there are over 200 companies listed in the Massachusetts Manufacturers Directory with these SIC numbers. Therefore, it may be reasoned that an even a small percentage of the total use is wire solder, it would still represent a substantial usage in Massachusetts.

SCOPE OF WORK

Carbon nanofibers have electrical conductivity that surpasses conventional carbon black pigments and are tolerated in greater concentrations by polymer matrices. This coupled with a heretofore, unidentified polymer matrix that would

enhance their conductivity might lead to an adhesive composition that potentially would offer an alternative to solder.

A group of polymers that might find utility in enhancing the electrical conductivity of nanotubes, would be POLYMERIC LIGHT EMITTING DIODES. Frank Karasz of UMASS Lowell, Department of Polymer Science and Engineering, has done some work investigating Π-conjugated macromolecules as candidates for large area light sources. Perhaps the photonic energy generated by the "excitonic decay" of the Π orbital electrons in these macromolecules could serve as a synergist for the conductivity of nanotubes dispersed in this matrix to the point of functioning as well as lead in an electric circuit.

Hyperion Catalysis reports that no meaningful work has been done to explore adhesives compounded with nanotubes as replacements for solder.
According to John Hagerstrom of Hyperion, the nanotubes they produce are "multiwalled nanotubes" which are unlike "Buckey Tubes" which are single walled. Multiwalled nanotubes are not as electrically conductive as single walled nanotubes and neither of which is as conductive as metallic silver or copper. However, Buckey Tubes are not commercially available.

<u>OBJECTIVE</u>
Develop an electrically conductive adhesive that will have electrical conductivity similar or equivalent to tin/lead solder normally used in current carrying devices. OTA can assist in the identification of an industry partner.